Citation:

Bes-Rastrollo M, van Dam RM, Martinez-Gonzalez MA, Li TY, Sampson LL, Hu FB. Prospective study of dietary energy density and weight gain in women *Am J Clin Nutr.* 2008 Sep; 88 (3): 769-777.

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Study Design:

Prospective Cohort Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To assess the long-term relationship between changes in dietary energy density and age-related weight gain in a large prospective cohort of young and middle-aged women (Nurses Health Study II).

Inclusion Criteria:

- The prospective cohort contained 116,671 female US nurses who were aged 22 to 24 years in study initiation in 1989
- Participants completed on the self-administered food-frequency questionnaire (FFQ) in 1991, 1995 and 1999.

Exclusion Criteria:

Women excluded for the present analysis included those who:

- Did not complete the dietary questionnaire in 1991
- Had more than nine food items left blank on the questionnaire
- Reported an unreasonable energy intake (<500 or >3,500kcal per day)
- Had a history of diabetes, cardiovascular disease or a diagnosis of cancer with the exception of non-melanoma skin cancer before 1999
- Had no physical activity data accessed in 1991 or 1997
- Were pregnant at the time of the 1991, 1995 and 1999 questionnaire administration
- Only provided 1991 baseline data
- Did not provide information on body weight at any time.

Description of Study Protocol:

Recruitment

The details for recruitment of the nurses health study to is not included in this paper.

Design

This is a prospective cohort study evaluating dietary intake as self-reported by semi-quantitative FFQ in 1991 1995 and 1999.

Dietary Intake/Dietary Assessment Methodology

- Dietary intake was evaluated by a self-administered FFQ in 1991, 1995 and 1999. The questionnaire was a 133 item semi-quantitative FFQ which was mailed to participants in 1991. Similar FFQs were used to collect dietary information in 1995 and in 1999
- Dietary energy density was calculated by dividing each subjects' reported daily intake of calories by the reported weight in grams of all food consumed. Caloric and non-caloric beverages were excluded from the calculation. However in a secondary analyses, they included the caloric beverages in the calculation of energy density.

Blinding Used

Not applicable.

Intervention

Not applicable.

Statistical Analysis

- The primary analysis was performed by a test of linear trend across quintiles of dietary energy density using the assigned median value for each quintile and treating them as continuous variables
- Data were adjusted for age, alcohol intake, physical activity, smoking and other lifestyle and dietary confounders at baseline and for each time period
- Subjects were also classified in categories of change in energy density across three different time periods:
    - 1991 to 1995
    - 1995 to 1999
    - 1991 to 1999.

Data Collection Summary:

Timing of Measurements

- Food-frequency questionnaires were obtained in 1991, 1995 and 1999
- The additional non-dietary exposure data were obtained by biennial questionnaires
- Physical activity was assessed in 1991 and 1997 by questionnaire.

Dependent Variables

- Variable 1: Change in body weight over time from 1991 through 1999. Body weight was assessed by self-report

Independent Variables

- Energy density of food intake, as reported on three FFQs (1991, 1995 and 1999) was the primary independent variable
- Energy density was calculated as total kcal per gram weight of food consumed. This variable was calculated with caloric and non-caloric beverages excluded
- In a secondary analysis caloric beverages were included in the energy density calculation.

Control Variables

- Ancillary variables were utilized in the analysis model and these included age, alcohol intake, physical activity, smoking and other lifestyle and dietary factors.

Description of Actual Data Sample:

- *Initial N:* 116,670
- *Attrition (final N):* Final sample size was 51,188 women
- *Age:* 24 to 44 years at study initiation
- *Ethnicity*: Ethnic distribution of subjects is not described
- *Other relevant demographics:* All study participants were nurses
- *Anthropometrics:* The primary anthropometric data obtained was body weight. Subjects self-reported body weight by questionnaire
- *Location:* Data analysis was performed at Harvard School of Public Health. Study participants are from all regions of the United States, although no description of their location is provided in the paper.

Summary of Results:

- Dietary energy density was positively associated with saturated fat (r=0.16), trans fat (r=0.15) and glycemic index (r=0.16)
- Dietary energy density was inversely associated with vegetable protein (r=-0.30), vegetables (r=-0.27) and fruit (r=-0.17)
- Dietary energy density was not associated with total fat intake
- Women who increased dietary energy density during the eight-year follow-up to the greatest extent had a significantly greater multivariate-adjusted weight gain than did those who decreased their dietary energy density (6.42kg compared to 4.57kg; $P<0.0001$).

Author Conclusion:

- The authors conclude that this longitudinal study shows an increase in total dietary energy density to be associated with a significantly greater weight gain over an eight-year follow-up period in healthy middle-aged women
- The magnitude of the weight change is related to the energy density value of individual foods and beverages, so that in this population, a higher energy density represented a dietary pattern characterized by higher intakes of saturated and trans fatty acids and refined carbohydrate and lower intakes of fruits and vegetables
- In addition the authors conclude that women who increased their dietary energy density had greater weight gain than those who decrease their energy density over time. However women who maintained a high energy density over the evaluated time period experienced a lower weight gain than those who in maintained a low energy density at baseline. The

authors suggest that this may be related to the tendency ofoverweight or obese individuals to try to reduce their energy density as a means of imposing body weight management.

Reviewer Comments:

- *Although the gain in body weight over time was related to higher energy density in this eight-year investigation, the data shows only a modest association between the variables, no direct link can be made to specific food patterns or specific food items in the weight gain described in the paper. Additionally, those women who maintained a higher energy density throughout the study maintained a lower weight gain*
- *Body weight was obtained by questionnaire, and although these investigators have data showing a high correlation between body weight as reported and as measured, there is no way to verify that in this study sample. In general, the results of this study support an association between increased weight gain with increased energy density over time in middle-aged women.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes

2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	N/A
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	N/A
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes

5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes

7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes